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PASSIVE HOUSE

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Energy effective houses are becoming more and more popular nowadays. Costs of electricity and heating are rising. An issue of exploitation costs of dwelling is an actual one. Rate of energy efficiency is a quantity of heat-loss on one square meter (kW·h/m^2) per one year. Average rate is 100-120 kW·h/m^2. A building can be pass for energy effective one, if this rate is lower than 40 kW·h/m^2.This rate for Europe countries is even lower, about 10 kW·h/m^2.

The term passive house (Passivhaus in German) refers to a rigorous, voluntary standard for energy efficiency in a building, reducing itsecological footprint. It results in ultra-low energy buildings that require little energy for space heating or cooling. A similar standard,MINERGIE-P, is used in Switzerland. The standard is not confined to residential properties; several office buildings, schools,kindergartens and a supermarket have also been constructed to the standard. Passive design is not an attachment or supplement to architectural design, but a design process that is integrated with architectural design. Although it is mostly applied to new buildings, it has also been used for refurbishments.

Estimates of the number of Passivhaus buildings around the world in late 2008 ranged from 15,000 to 20,000 structures. As of August 2010, there were approximately 25,000 such certified structures of all types in Europe, while in the United States there were only 13, with a few dozens more under construction. The vast majority of passive structures have been built in German-speaking countries and Scandinavia.

The eventual building of four row houses (terraced houses or town homes) was designed for four private clients by the architectural firm of Bott, Ridder and Westermeyer. The first Passivhaus residences were built in Darmstadt, Germany in 1990, and occupied by the clients the following year.

Passive solar design and landscape

Passive solar building design and energy-efficient landscaping support the Passive house energy conservation and can integrate them into a neighborhood and environment. Following passive solar building techniques, where possible buildings are compact in shape to reduce their surface area, with principal windows oriented towards the equator - south in the northern hemisphere and north in the southern hemisphere - to maximize passive solar gain. However, the use of solar gain, especially in temperate climate regions, is secondary to minimizing the overall house energy requirements. In climates and regions needing to reduce excessive summer passive solar heat gain, whether from direct or reflected sources, Brise soleil, trees, attached pergolas with vines, vertical gardens, green roofs, and other techniques are implemented.

Passive houses can be constructed from dense or lightweight materials, but some internal thermal mass is normally incorporated to reduce summer peak temperatures, maintain stable winter temperatures, and prevent possible overheating in spring or autumn before the higher sun angle "shades" mid-day wall exposure and window penetration. Exterior wall color, when the surface allows choice, for reflection or absorption insolation qualities depends on the predominant year-round ambient outdoor temperature. The use of deciduoustrees and wall trellised or self attaching vines can assist in climates not at the temperature extremes.

Superinsulation

Passivhaus buildings employ superinsulation to significantly reduce the heat transfer through the walls, roof and floor compared to conventional buildings. A wide range of thermal insulationmaterials can be used to provide the required high R-values (low U-values, typically in the 0.10 to 0.15 W/(m².K) range). Special attention is given to eliminating thermal bridges.

A disadvantage resulting from the thickness of wall insulation required is that, unless the external dimensions of the building can be enlarged to compensate, the internal floor area of the building may be less compared to traditional construction.

In Sweden, to achieve passive house standards, the insulation thickness would be 335 mm (about 13 in) (0.10 W/(m².K)) and the roof 500 mm (about 20 in) (U-value 0.066 W/(m².K)).

Airtightness

Building envelopes under the Passivhaus standard are required to be extremely airtight compared to conventional construction.

Passive house is designed so that most of the air exchange with exterior is done by controlled ventilation through an heat-exchanger in order to minimize heat loss (or gain, depending on climate), so uncontrolled air leaks are best avoided.

Another reason is the passive house standard makes extensive use of insulation in which usually requires a careful management of moisture and dew points.

This is achieved through air barriers, careful sealing of every construction joint in the building envelope, and sealing of all service penetrations.

Passive cooling and ventilation

The essential principle of passive cooling is to prevent heat from entering the building, or remove heat once it has entered. The main methods employed within the Indian context are ventilation cooling, evaporative cooling, nocturnal radiation cooling, desiccant cooling and earth coupling. The success of these concepts depends greatly depends upon localized climatic conditions.

Natural ventilation and airflow utilize breezes to create air movement through a building and the resultant cooling. Effective ventilation requires openings to be in opposite pressure zones. If the inlet and outlet are placed at different heights, air flows from the inlet to the outlet due to the

density difference created by the upward movement of warm air. Ventilation requirements of different seasons and for different types of occupancies should be determined early on in the design process to create an effective passive system with minimized dependence on mechanical means.

A key area in ventilation design is the principle of air changes per hour referred to as '**ACH**'. This is essentially the capacity of a space to dissipate heat. With key data of air density, ventilation rates, specific heat of the air, and the internal and external temperature differences optimal air change rates can be calculated for different spaces. Figure 8 states a selection of air-change rates per hour for different types spaces.

Following are some passive cooling and ventilation systems:

- Cross ventilation: When a building is cross ventilated during the day, the temperature of the indoor air is similar the ambient temperature for the basic cross ventilation rule of thumb). Cross ventilation is an absolute must for warm and humid climates to remove the excess heat input from the external environment.

- Stack effect: A lot of air movement indoors is created through the stack effect and wind pressure. Stack effect can be created by differences in temperature or humidity. For example, a duct with an elevated vent above the terrace level is effective in inducing air movement inside the building through the stack effect. Such an arrangement expels hot air which is replaced by incoming air from other openings and is called a solar chimney.

- Wind towers: Similarly, wind towers use wind pressure for cooling. The change of temperature and thereby the density of the air in and around the tower creates a draft, pulling air either upwards or downwards through the tower.

- Evaporative cooling: The outdoor air is cooled by evaporating water before it enters a building. A water body such as a pond, lake or sea near the building, or even a fountain can provide a cooling effect. This is a highly effective technique for predominantly hot and dry climates and can be greatly enhanced by system design which integrates high quality cooling surfaces or pads with the required air flow rate for the given building. A variant of the system is Passive downdraft evaporative cooling which consist of a downdraft tower with wetted cellulose pads at the top of the tower. These cool the air flowing over them, causing air to sink into the body of the house and hot air to rise up.

- Nocturnal cooling: This occurs if the ambient air is cooler than the room air. The interior mass of the building is cooled and on the next day the cooled mass reduces the rate of indoor temperature rise providing a cooling effect.

- Earth Coupling: Utilizing the earth as a massive heat sink this method is for both heating and cooling. At a depth of 4-5m below ground, seasonal variations of temperature within soil remain fairly constant. Ambient air is blown through a section of buried pipe and is cooled in summer and heated in summer (figure 2.31) for a typical earth coupling section.

Use of passive natural ventilation is an integral component of passive house design where ambient temperature is conducive — either by singular or cross ventilation, by a simple opening or enhanced by the stack effect from smaller ingress with larger egress windows and/or clerestory-operable skylight.

When ambient climate is not conducive, mechanical heat recovery ventilation systems, with a heat recovery rate of over 80% and high-efficiency electronically commutated motors (ECM), are employed to maintain air quality, and to recover sufficient heat to dispense with a conventional central heating system.[2] Since passively designed buildings are essentially air-tight, the rate of air change can be optimized and carefully controlled at about 0.4 air changes per hour. All ventilation ducts are insulated and sealed against leakage.

Some Passivhaus builders promote the use of earth warming tubes (typically ≈200 mm (~7,9 in) diameter, ≈40 m (~130 ft) long at a depth of ≈1.5 m (~5 ft)). These are buried in the soil to act as earth-to-air heat exchangers and pre-heat (or pre-cool) the intake air for the ventilation system. In cold weather the warmed air also prevents ice formation in the heat recovery system's heat exchanger. Concerns about this technique have arisen in some climates due to problems with condensation and mold.[33]

Alternatively, an earth to air heat exchanger can use a liquid circuit instead of an air circuit, with a heat exchanger (battery) on the supply air.

Passive Heating

Direct gain is a passive heating technique that is generally used in cold climates and is the most common, simple, cheap and effective heating approach. In this technique, sunlight is admitted into the living spaces directly through openings or glazed windows. The sunlight heats the walls and floors, which then store and transmits the heat to the indoor environment.

Sun spaces are a common approach to passive heating, usually in the form of an attached glazed room or solar greenhouse . The sun space acts as a solar collector, admitting solar radiation and storing it within interior surfaces such as a mass wall. Some of the heat is rapidly transferred by natural convection to the sunspace air and some of it flows into massive elements within the sunspace (floor, walls and water containers) to be returned later. The sunspace is, thus, a direct gain space in which heat is used directly to maintain a temperature suitable for its function, such as a secondary living space. This may be by conduction through a masonry common wall, by natural convection through openings (doors, windows, or special vents) in the common wall[1].

The main requirements of a direct gain system are large glazed windows to receive maximum solar radiation and thermal storage mass. Direct gain can result in overheating, glare and degradation of building materials due to ultraviolet radiation are some of its disadvantages. During the day, the affected part of the building tends to get very hot, and hence, thermal storage mass is provided in the form of bare massive walls or floors to absorb and store heat.

This also prevents overheating of the room. The stored heat is released at night when needed most for space heating.

References

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